Low radiation and low contrast dose coronary CT angioraphy at 64-row CT: usefulness of BMI-adapted protocol and the iterative reconstruction algorithm

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Aims and objectives

To evaluate the effect on image quality of a low radiation dose and contrast agent dose for coronary computed tomography angiography (CCTA) using a BMI-adapted protocol and the iterative reconstruction algorithm with prospective ECG triggering.
Methods and materials

Patient preparation and CT examination

Between April and October 2014, 196 patients referred for CCTA to rule out coronary artery disease were prospectively enrolled. The exclusion criteria included: nonsinus rhythm, Heart Rate>75 bpm, a history of allergic reactions to iodinated contrast agent, renal insufficiency (creatinine level>1.7 mg/dL), hemodynamic instability or pregnancy. Oral metoprolol (25-50 mg) was administered 60 min before CCTA examination, if necessary, to achieve a heart rate <75 bpm. In addition, the measurement of body weight and height was manually performed by an investigator just before the scan.

All scans were performed prospectively ECG-triggered, using a 128-slice Brilliance iCT scanner. Patients were divided into four groups using kV/ref.mAs=80/200, 100/150, 120/150 and 140/150 when patient’s Body mass index (BMI) was #18.5 (n=21), 18.5-24.0 (n=76), 24.0-28.0 (n=64) and>28.0 (n=35), respectively. The contrast dose and flow rate was divided into 50ml/4.0 mL/s, 60ml/4.5 mL/s, 70ml/5.0 mL/s, 70ml/5.0 mL/s correspondingly. Iopamidol at 370 mg I/mL was continuously injected into an antecubital vein using a power intector. Bolus tracking was performed with a region of interest (ROI) placed into the descending aorta. Scanning was performed from below the tracheal bifurcation to the diaphragm. The other parameters used in the scan and reconstruction were the same. These parameters were as follows: slice acquisition, 64×0.625 mm; smallest x-ray window (75% of the R-R cycle); z-coverage value of 40 mm with an increment of 35 mm; gantry rotation time 350 milliseconds. All the images were post-processed with the iterative reconstruction technique.

Effective dose radiation estimation

Radiation dose parameters were recorded with volume CT Volume dose index (CTDIvol) in mGy, dose-length product (DLP) in mGy cm and effective dose (ED) in mSv. The CTDIvol and the DLP were automatically determined and recorded from the CT scanner at the end of each examination. The ED was calculated by multiplying the DLP by a conversion coefficient for the chest (k = 0.014 mSv/mGy•cm)[12].

CCTA image evaluation

All of the images were evaluated independently by two radiologists with 5 and 10 years of CCTA experience. Coronary arteries were divided into 16 segments for analysis of CCTA data as proposed by the American Heart Association. Image quality was evaluated on
a 4-point scale (1 = excellent; 2 = blurring of the vessel wall; 3 = image with artifacts but evaluative; 4 = non-evaluative).

The quantitative image quality was measured by the image noise, signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). The regions of interest (ROI) was placed at the root of the ascending aorta, the proximal opening of the right coronary artery (RCA), left main artery (LMA) and the adjacent fat tissue peripheral to RCA or LMA. The size of ROI was 100 mm$^2$ at the aorta root, and as large as possible at RCA, LMA, and perivascular fat. The calcifications, plaques, and stenoses were avoided for ROI placement. The image noise was defined as the standard deviation of ROI measurement at aorta. The contrast of RCA and LMA was the difference of CT value between the vessel lumen and the adjacent perivascular fat. The SNR was defined as average CT value divided by image noise at aorta. The CNR in RCA and LMA was defined as the contrast of RCA and LMA divided by image noise.

**Statistical analysis**

The statistical analysis was performed using SPSS software (IBM, SPSS statistics, version 19). The quantitative variables were expressed as mean±standard deviation and the categorical variables as frequencies or percentages. Differences between four groups were assessed by using ANOVA. A P value of < 0.05 was considered to indicate statistical significance.
Results

BMI ranged from 16.3 to 33.6 cm, the contrast dose was 50ml-70ml and the flow rate was 4.0-5.0 mL/s. Mean effective radiation dose was 0.9-3.4 mSv. The image quality scores indicated no significant difference among the four groups with regard to each score rate (all P>0.05). Image noise, vessel attenuation and SNR were higher in 80 kV and 100 kV groups than that of 120 kV and 140 kV groups (P<0.05), while CNR in RCA and LM were not significantly different among the four groups (P >0.05).
Fig. 1: 77-year-old woman with BMI of 17.9kg/m². Axial CT images obtained at 80kV/200mAs, with contrast dose of 40ml, show ascending aorta with image noise of 38.1HU and vessel attenuation of 687.6HU. Excellent image quality was obtained.

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Fig. 2: 80-year-old woman with BMI of 23.7kg/m². Axial CT images obtained at 100kV/150mAs, with contrast dose of 45ml, show ascending aorta with image noise of 35.2HU and vessel attenuation of 558.5HU. Excellent image quality was obtained.

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Fig. 3: 43-year-old man with BMI of 26.0kg/m². Axial CT images obtained at 120kV/150mAs, with contrast dose of 50ml, show ascending aorta with image noise of 29.3HU and vessel attenuation of 413.5HU. Excellent image quality was obtained.

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**Fig. 4:** 44-year-old man with BMI of 29.4kg/m². Axial CT images obtained at 140kV/150mAs, with contrast dose of 50ml, show ascending aorta with image noise of 22.0HU and vessel attenuation of 354.9HU. Excellent image quality was obtained.

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Conclusion

BMI-adapted protocol and the iterative reconstruction algorithm can be used for individualized radiation dose and contrast control, resulting in similar CNR and maintaining diagnostic image quality.
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References


